جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Mechatronics - ME 222A

Division	Physical Science and Engineering Division
Course Number	ME 222A
Course Title	Mechatronics
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	02:30 PM - 04:00 PM | Sun Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Mohammad Ibrahim Younis	Mohammad.Younis@KAUST.EDU.SA	+966128080597		Sunday and Thursday: 1-2 PM

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	A first course in Mechatronics with a focus on the modeling and simulation of micro electromechanical systems MEMS. The course will emphasize lumped-parameter modeling techniques, nonlinear analyses principles, and continuous beam theories. Design principles, analytical techniques, and numerical tools will be emphasized. The course involves a course project, in which the student is supposed to apply the analytical and numerical tools to simulate and design a MEMS/ NEMS device.
Course Description from Program Guide	Principles, modeling, interfacing and signal conditioning of motion sensors and actuators; acquire and analyze data and interact with operators. Basic electronic devices, embedded microprocessor systems and control, power transfer components and mechanism design. hardware-in-the-loop simulation and rapid prototyping of real-time closed-loop computer control of electromechanical systems; modeling, analysis and identification of discrete-time or samplesdata dynamic systems; commonly used digital controller design methods; introduction to nonlinear effects and their compensation in mechatronic systems; robotic manipulation and sensing; obstacle avoidance and motion planning algorithms; mobile robots, use of vision in navigation systems. The lectures will be divided between a review of the appropriate analytical techniques and a survey of the current research literature. Course work will focus on an independent research project chosen by the student.
Goals and Objectives	-Learning new modeling and simulation of electromechanical systems. -Learning new numerical and analytical techniques to tackle and analyze nonlinear systems. -Have good knowlede of MEMS/NEMS, thier general features, design issues, and solutions.
Required Knowledge	-Good standing in numertical simulations. -Good standing in mathematical modeling.
Reference Texts	*MEMS Linear and Nonlinear Statics and Dynamics*, Younis, Mohammad I., Springer, New York, 2011.
Method of evaluation	**35.00**% - Research Project **45.00**% - Homework /Assignments **20.00**% - Exam 1

Nature of the assignments	Weekely Homeworks involving numerical and/or analytical problems.
Course Policies	**Grading policy:** Homework 45%, Project: 35%, Test: 20%. **Attendance:** Is encouraged all time. Students should come no latter than 5 minutes of the start of the class.
Additional Information	**Course Project:** -A report in the form of a research paper (10-15 pages) is due before the last class of the semester. -Each student will need to deliver 10-15 minutes presentation of his/her project at the end of the semester. -The topic of the project should be about investigating the mechanical behavior of a MEMS/NEMS device using the techniques taught in the course. -The techniques include the lumped-parameter models, the continuous beam models, and the finite element models. -The static and dynamic aspects of the device need to be analyzed. -Examples of results include static deformations, pull-in (if any), natural frequencies, phase portraits, stability analysis, and new designs. -Validation and comparison with finite-element or experimental data for some of the report results is a must. The data for comparison can be from the literature. -You can choose the device of your choice after conducting a literature survey. -Examples (suggested) of topics: -MEMS probes for brains. -MEMS robotics. -NEMS devices based on Graphene or Carbon Nano Tubes CNTs. -MEMS energy harvesters. -You need to model and simulate the static and dynamic behavior of the device. -It is recommended to consult me on the topic and your plans. -The report should be written using your own words only. **Direct copying** from any paper, web, or other sources is **prohibited** and will result in a zero grade. -The report should be written in a Journal paper format. It may include a literature summary about the topic, introduction about the system from a mechatronics point of view, section about the used model, simulation results and comparisons with literature results/ experiments, summary and conclusions, and recommendations (research ideas) for future works.

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Sun 08/26/2018	Introduction to Mechatronics/MEMS
1	Wed 08/29/2018	-Microcontrollers and Microprocessors
2	Sun 09/02/2018	Operational Amplifiers (Op Amp)
2	Wed 09/05/2018	Logic Gates
3	Sun 09/09/2018	Data Acquisition
3	Wed 09/12/2018	Signal Processing, FFT
4	Sun 09/16/2018	-Free Vibration of Single-Degree-of-Freedom Systems -Forced Harmonic Excitation of Single-Degree-of-Freedom Systems
4	Wed 09/19/2018	-Vibrating MEMS Gyroscopes
5	Sun 09/23/2018	-Base Excitations of SDOF Systems and Accelerometers Principles -Vibrations of Two-Degree-of-Freedom Systems
5	Wed 09/26/2018	-Numerical Integration -MEMS Band-Pass Filters
6	Sun 09/30/2018	-Electrothermal Actuation
6	Wed 10/03/2018	-Piezoelectric Actuation and Detection
7	Sun 10/07/2018	-Electromagnetic and Magnetic Actuation
7	Wed 10/10/2018	-Peizoresistive Detection
8	Sun 10/14/2018	-Electrostatic Actuation and Detection (simple parallel-plate, comb-drive, torsional mirrors)
8	Wed 10/17/2018	-Resonant Sensors
9	Sun 10/21/2018	Stiffness of Microstructures
9	Wed 10/24/2018	-Spring-Mass Models
10	Sun 10/28/2018	-Damping in MEMS (focus mainly on squeeze film damping and some gas fundamentals)
10	Wed 10/31/2018	-Nondimensionalization
11	Sun 11/04/2018	-Fixed Points and Linearization
11	Wed 11/07/2018	-Bifurcations of Fixed Points
12	Sun 11/11/2018	-Phase Portraits
12	Wed 11/14/2018	-Step-Input Actuation of Capacitive RF Switches
13	Sun 11/18/2018	-Dynamics of Torsional Actuators and Micromirrors
13	Wed 11/21/2018	-Nonlinear Oscillations
14	Sun 11/25/2018	**Microbeams**
14	Wed 11/28/2018	static
15	Sun 12/02/2018	linear vibration
15	Wed 12/05/2018	reduced order modeling

16	Sun 12/09/2018	beams under electrostatic forces

Note

The instructor reserves the right to make changes to this syllabus as necessary.